

# Pre-Tropical Cyclone Squall Lines and the Connection to the Diurnal Cycle during Hurricane Laura (2020)

Vivian L. Brasfield<sup>1</sup>, Patrick T. Duran<sup>2</sup>, and Ryan A. Wade<sup>1</sup>

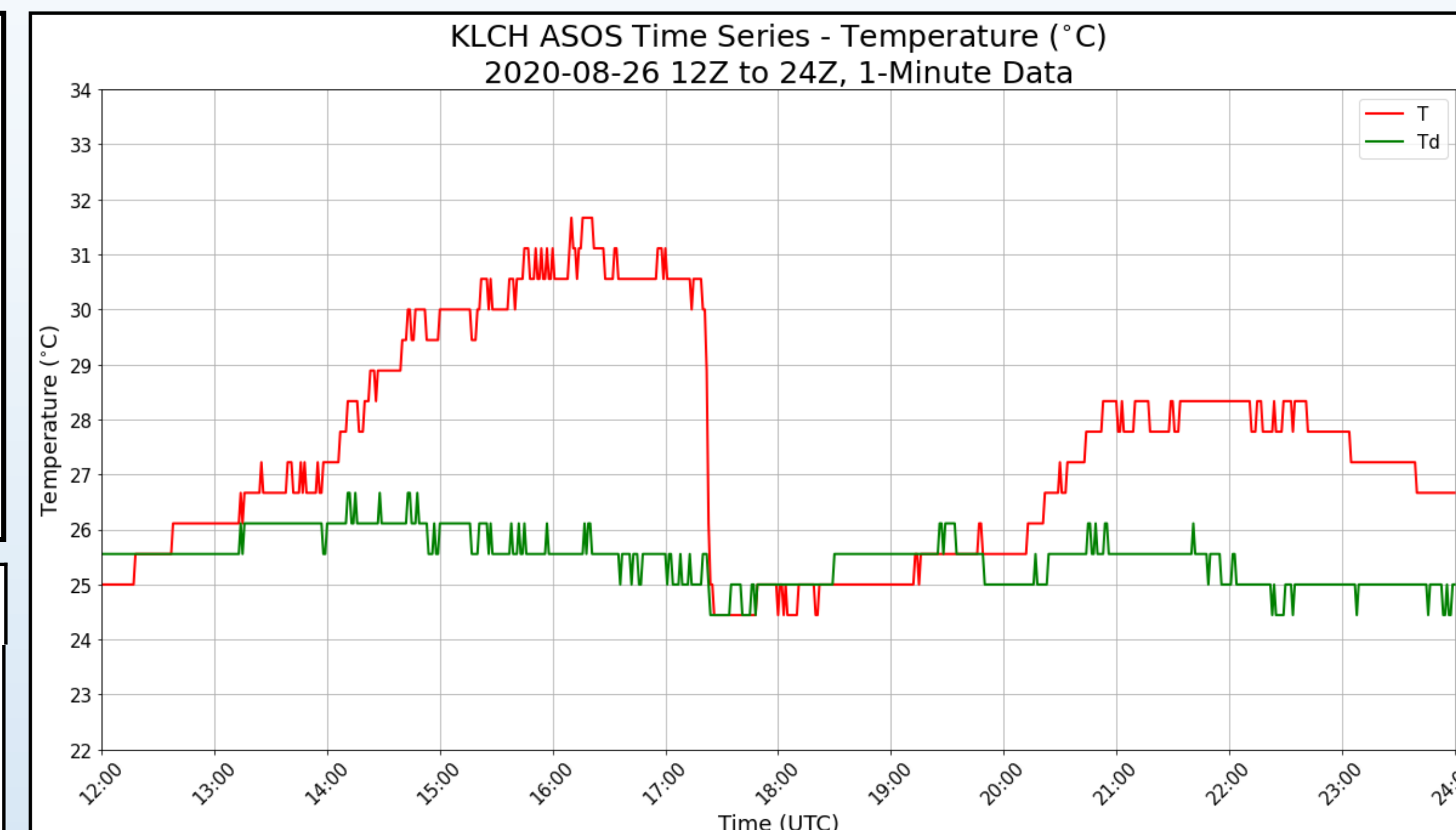
<sup>1</sup>University of Alabama in Huntsville, Huntsville, Alabama <sup>2</sup>NASA MSFC, Short-Term Prediction Research and Transition Center

**Motivation:** A squall line produced by Hurricane Laura (2020) generated several tornado and severe thunderstorm warnings in south Louisiana. Investigating the behavior, characteristics, and possible causes of these pre-TC squall lines will help better prepare forecasters in the future and aid in the understanding of TCs and the TC diurnal cycle as a whole.

**Background:** Previous studies such as Meng & Zhang, 2012; Parker & Johnson, 2000; and Bluestein & Jain, 1985 have characterized midlatitude squall lines as well as pre-TC squall lines in the Pacific Ocean Basin. These studies were used to model this investigation as well as provide quantitative criteria for this case study.

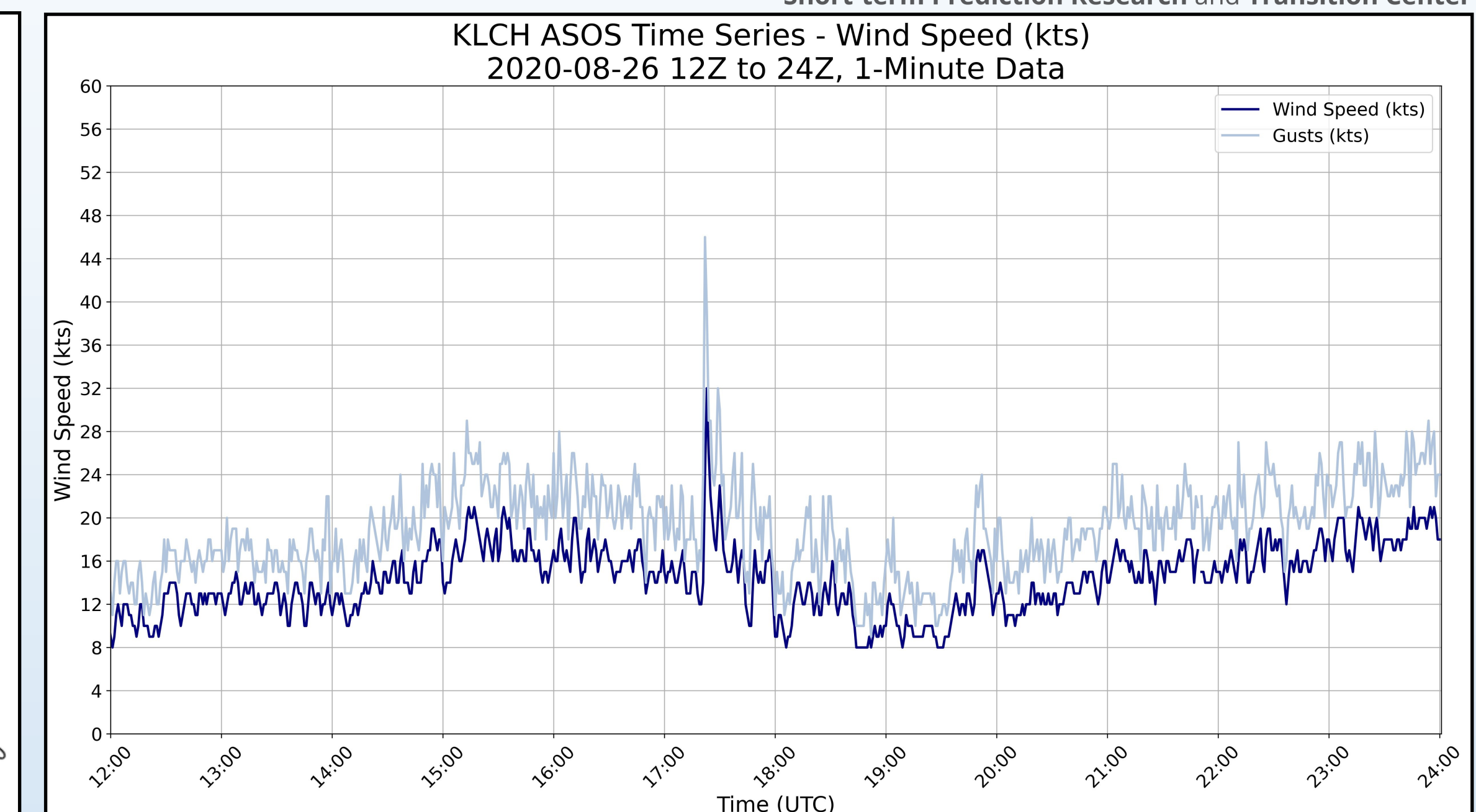
## Research Questions:

1. Do pre-TC squall lines have similar characteristics as midlatitude squall lines?
2. Are these pre-TC squall lines behaving more like TC rain bands or midlatitude squall lines?
3. What type of environment are the pre-TC squall lines forming in?
4. Do these pre-TC squall lines form and propagate in a manner consistent with the diurnal pulses within the TC diurnal cycle?
5. How is the HRRR forecast model resolving the pre-TC squall line in each case?



## KLCH 1-minute ASOS Data

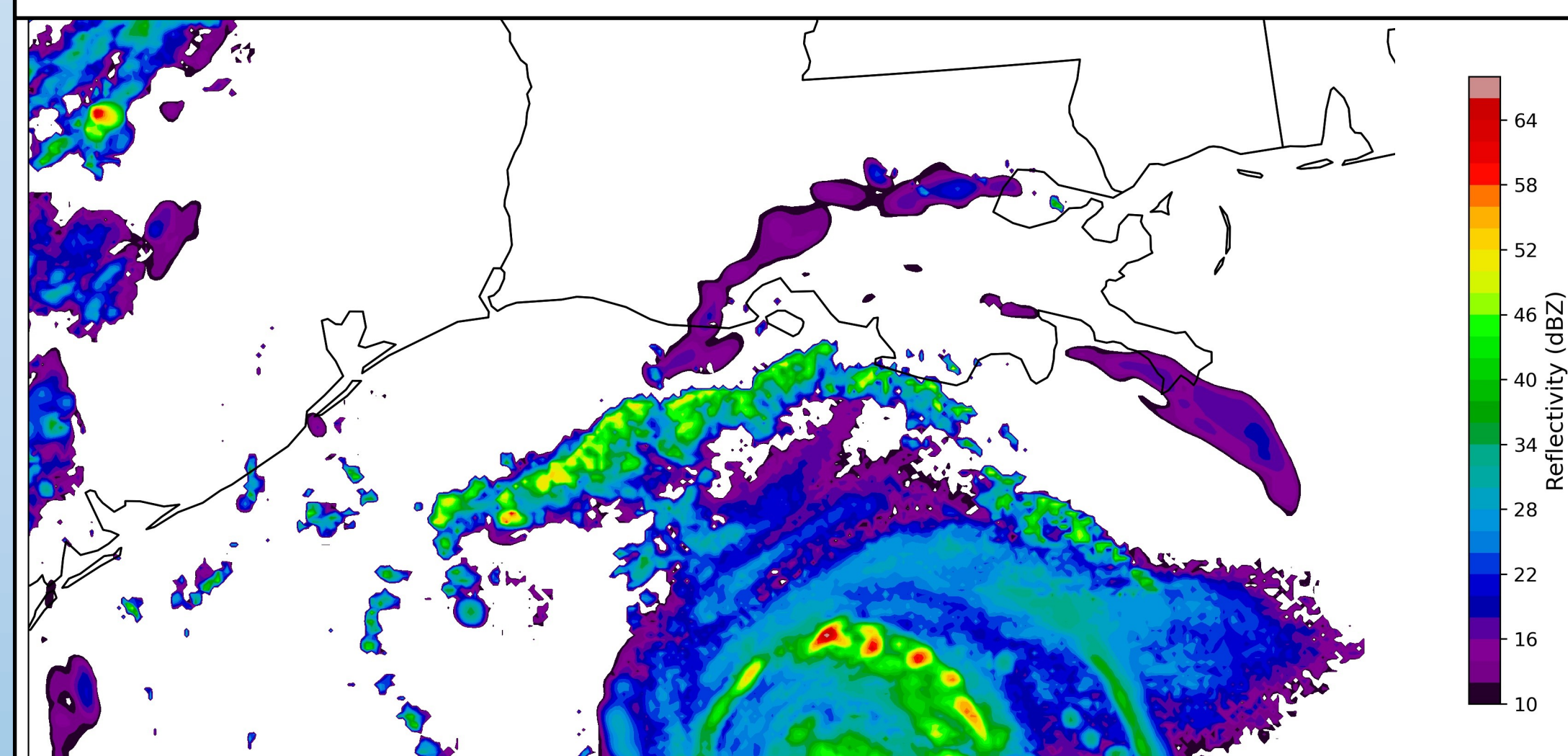
$\Delta T : -6.1^{\circ}\text{C}$  in 7 minutes



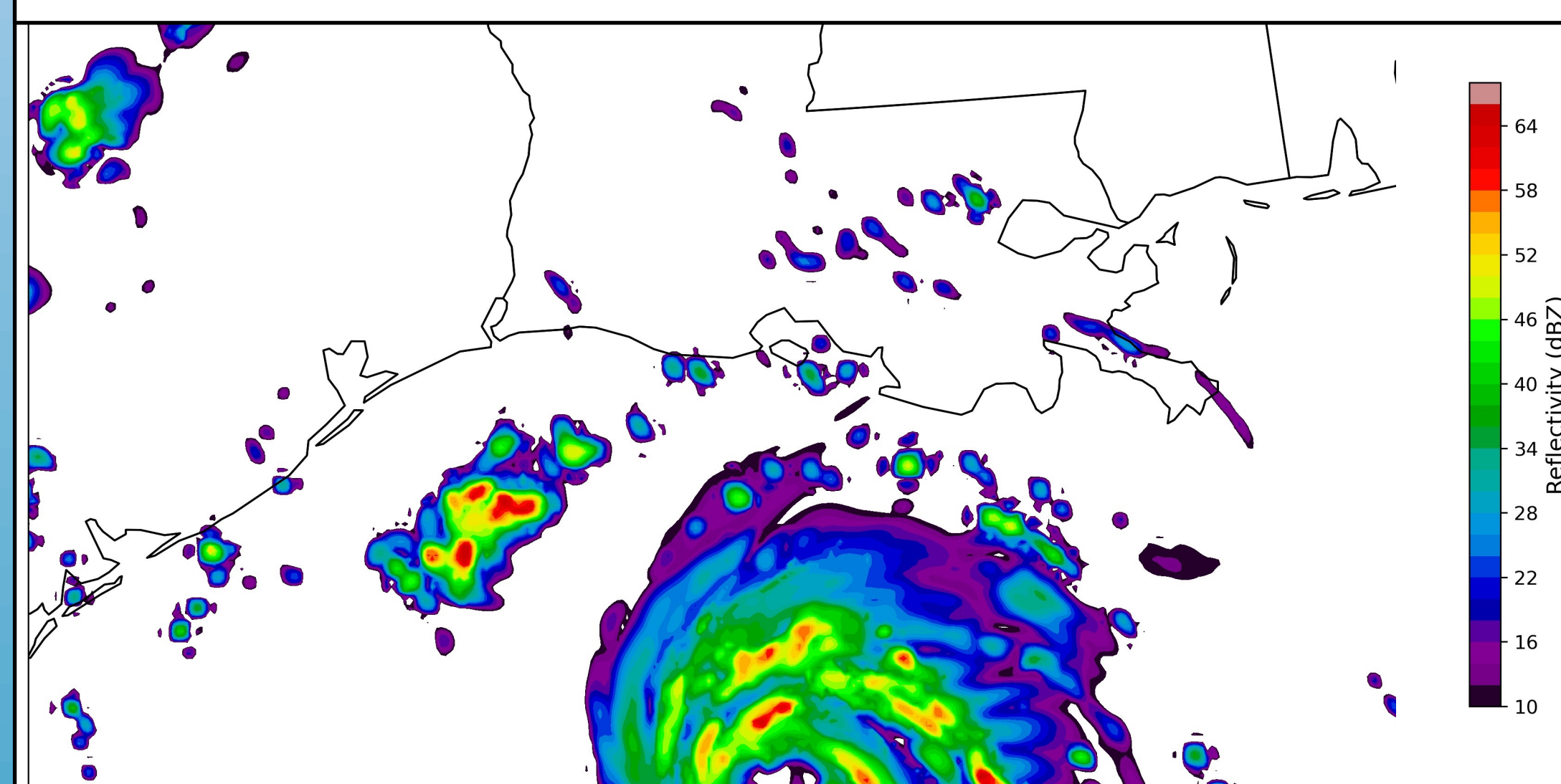
## Peak Sustained Wind Speed: 32 kts

Peak Wind Gust: 46 kts

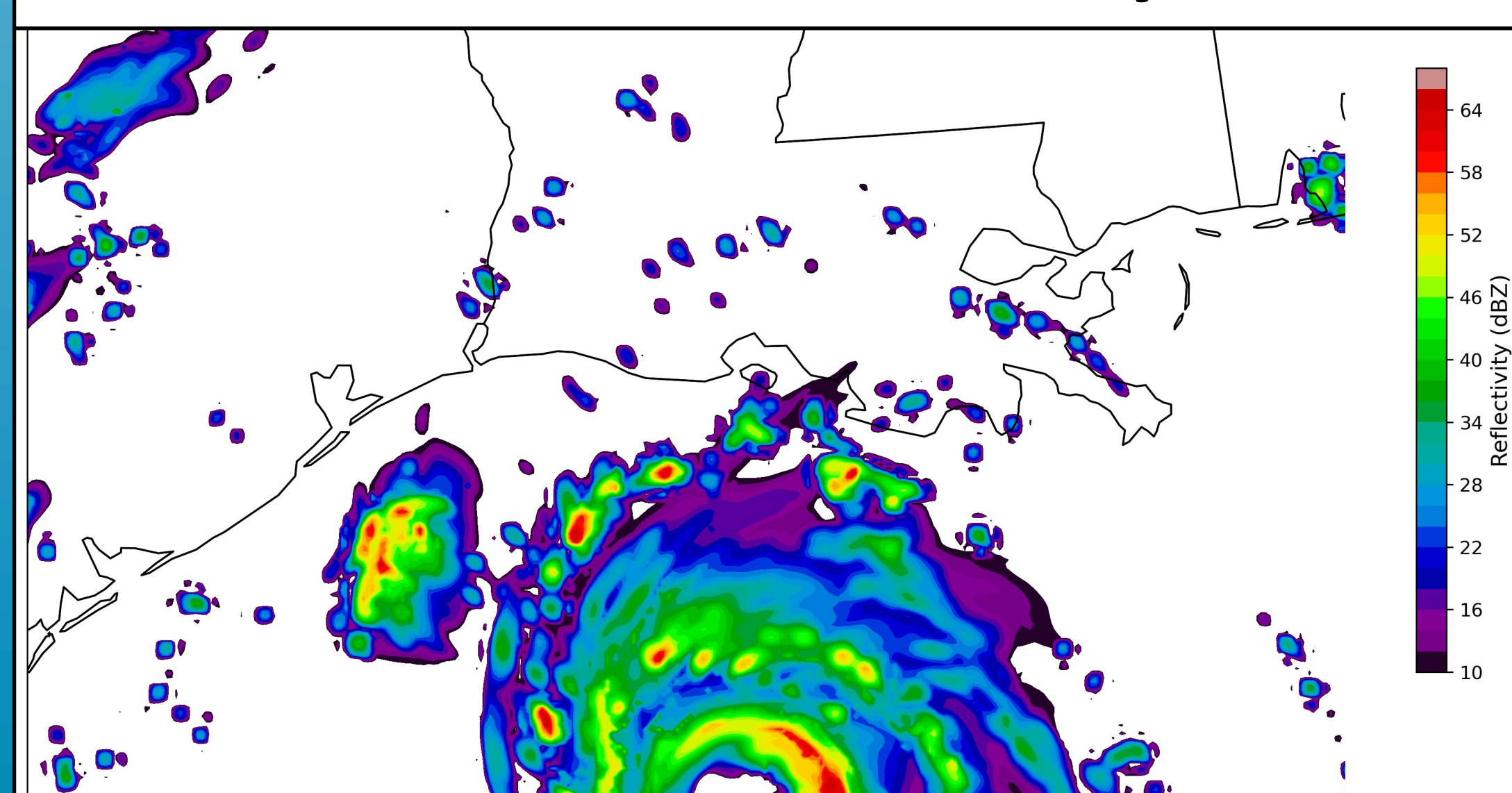
## 15Z Analysis Reflectivity



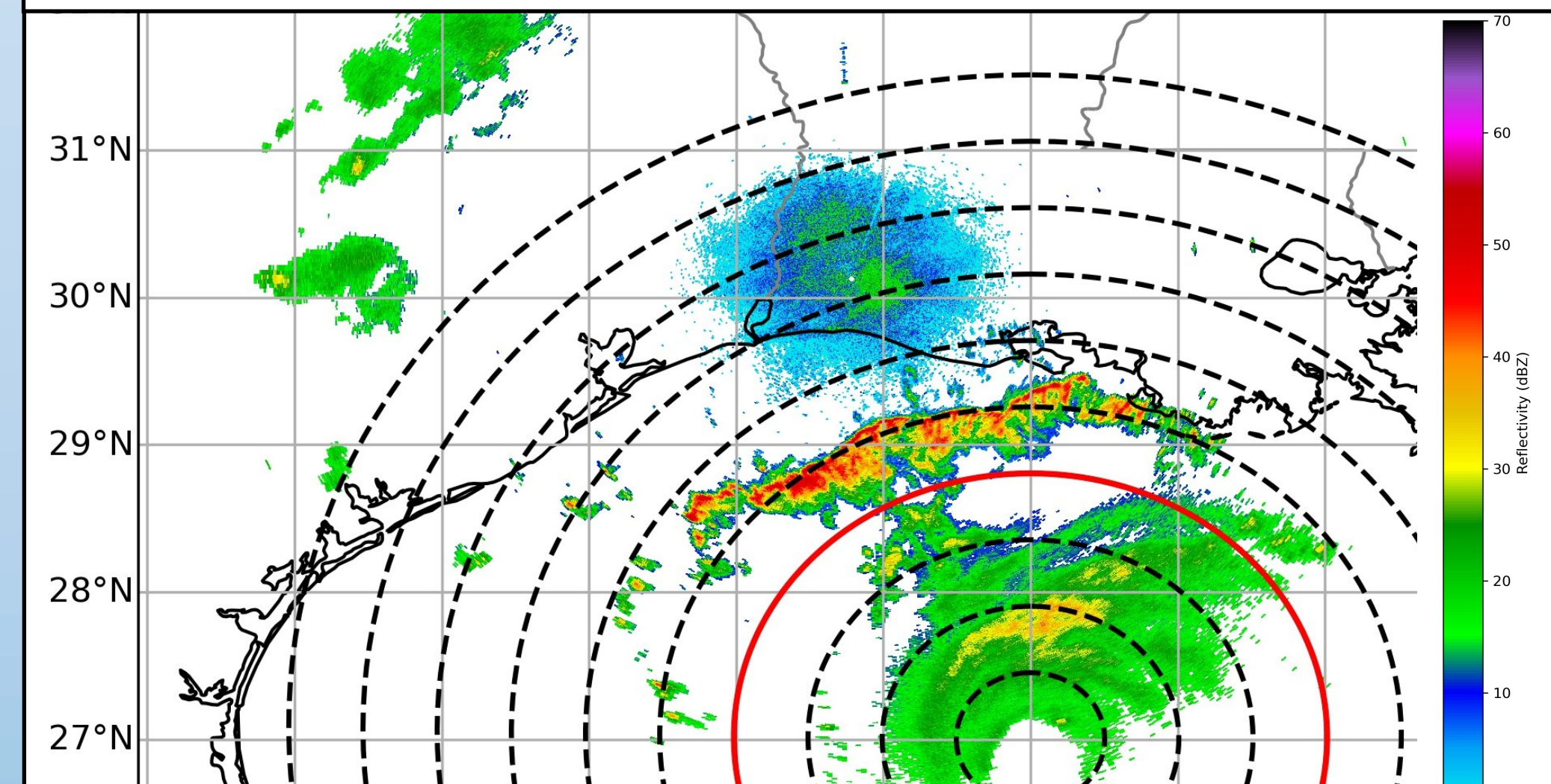
## 15Z Forecast Run Reflectivity for 16Z



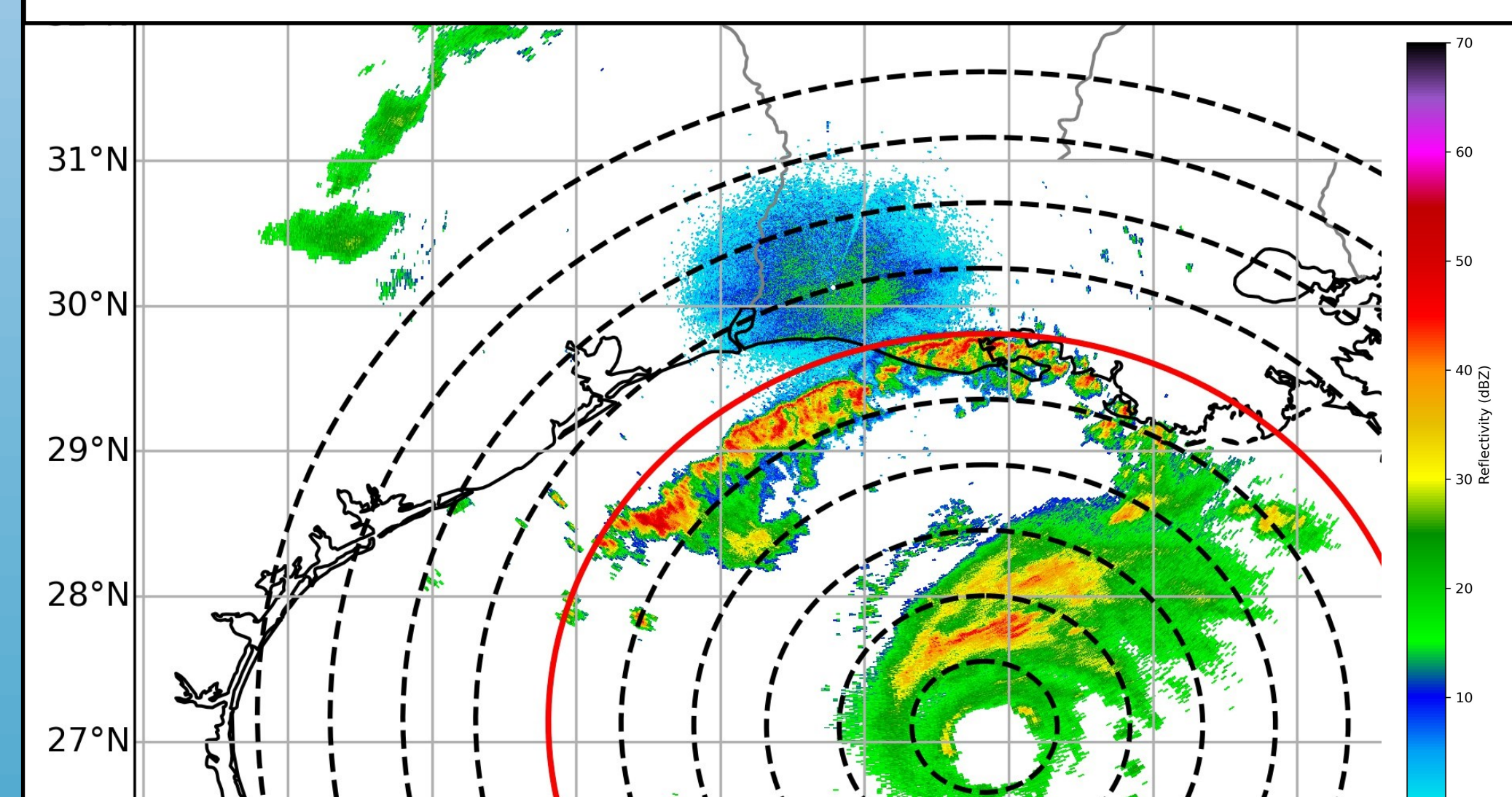
## 15Z Forecast Run Reflectivity for 17Z



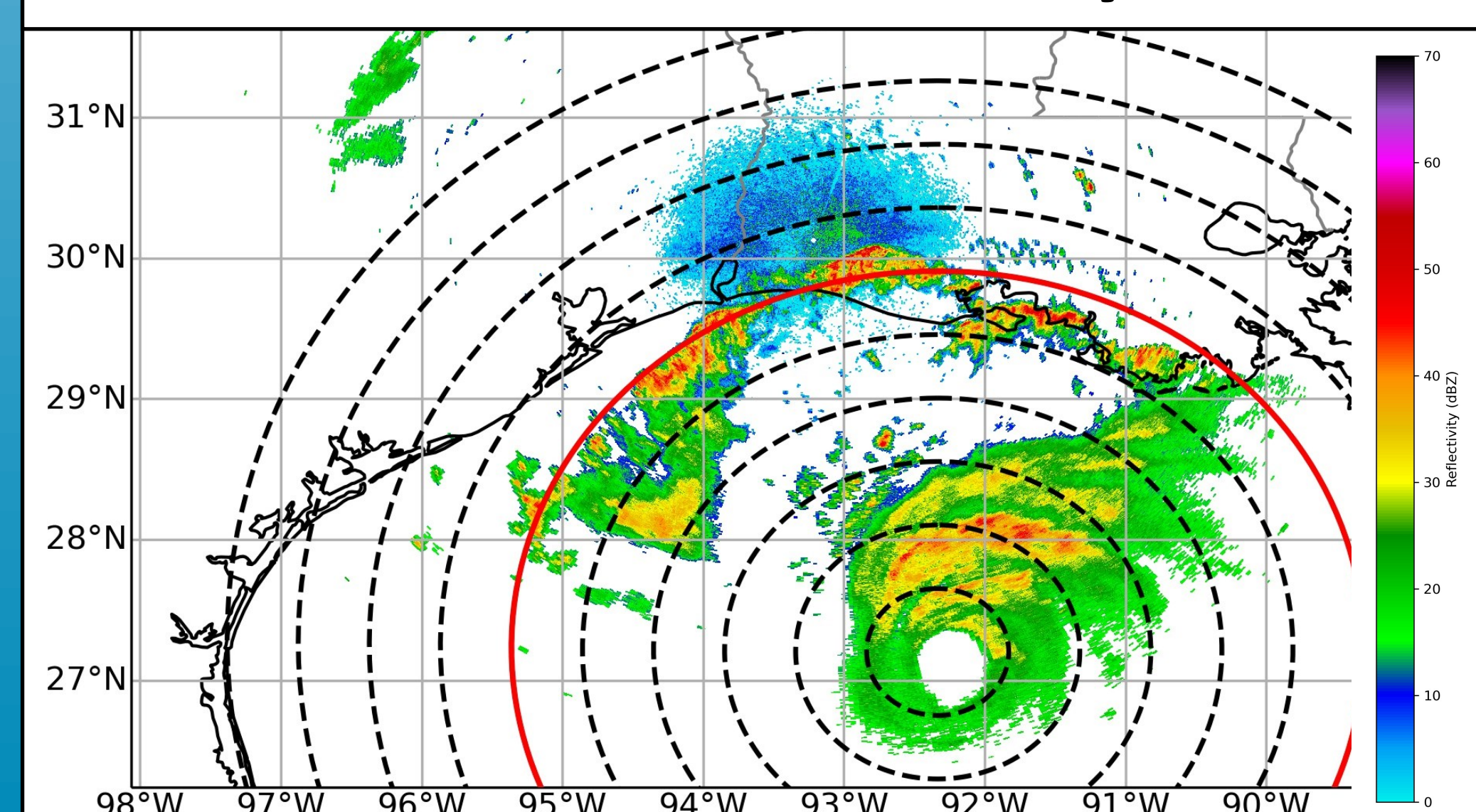
## KLCH Observed Reflectivity, 1459Z



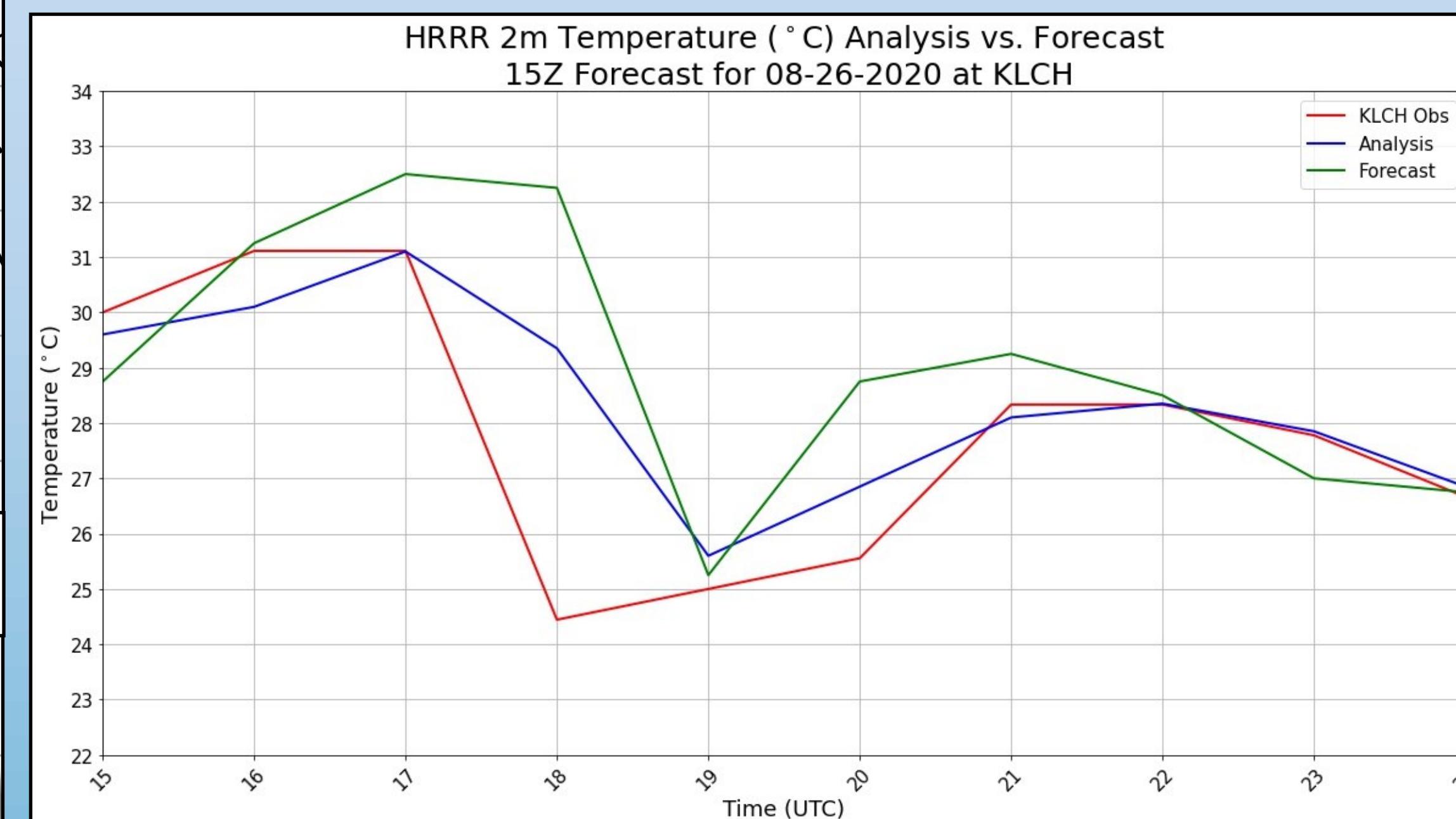
## KLCH Observed Reflectivity, 1601Z



## KLCH Observed Reflectivity, 1705Z

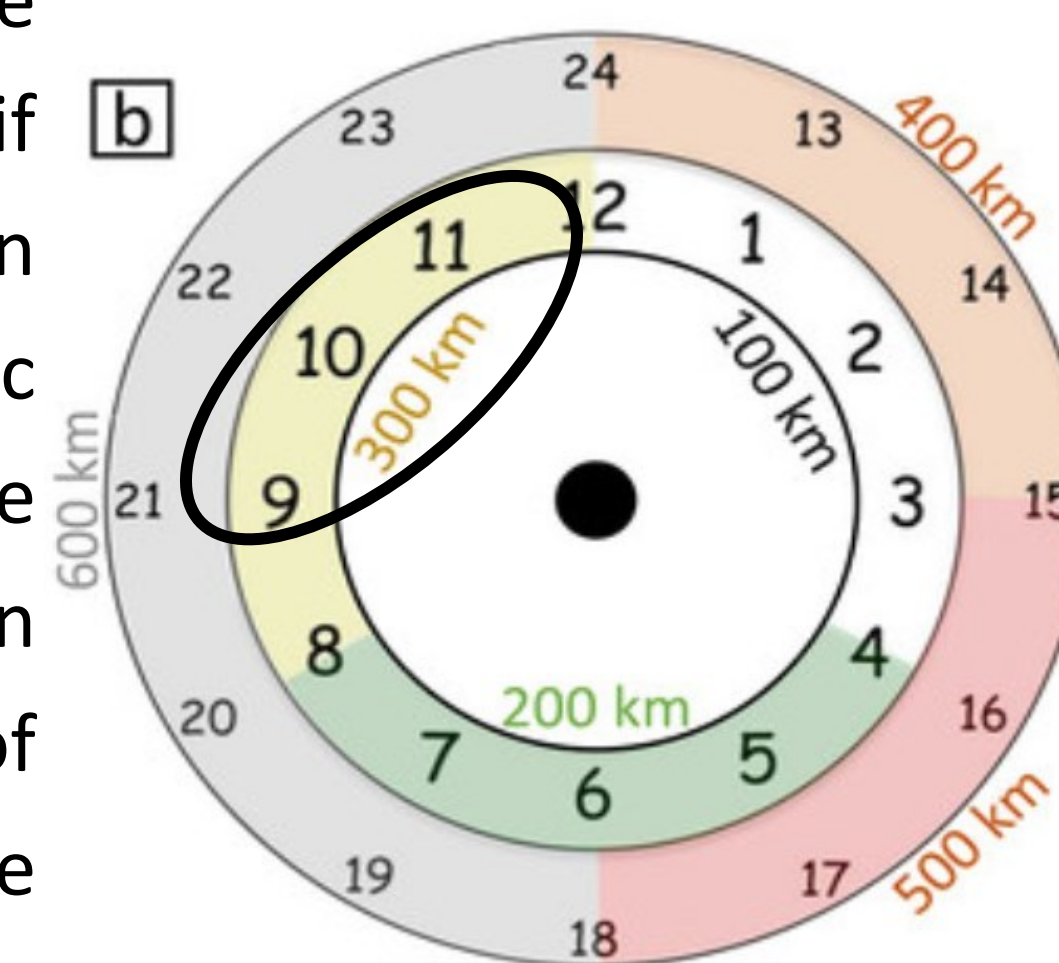


## 15Z HRRR 2m Temperature Forecast & Analysis comparison with KLCH obs.



## TC Diurnal Cycle Discussion

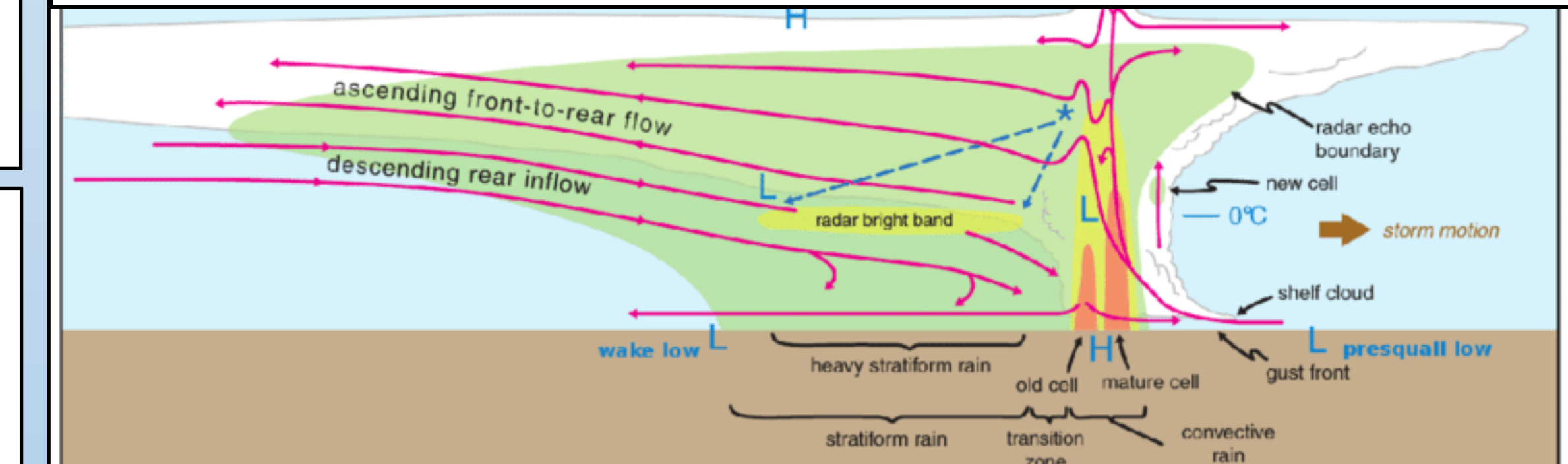
Based on the expanded diurnal clock from Ditchek et al. 2019 (below), distances were measured for Laura's squall line at key times during its lifespan and were classified in order to determine if they lined up with this clock. In the radar images below, an arc with radius 300km from the center of the TC has been drawn to illustrate the spatial extent of the diurnal pulse based on the diurnal clock.



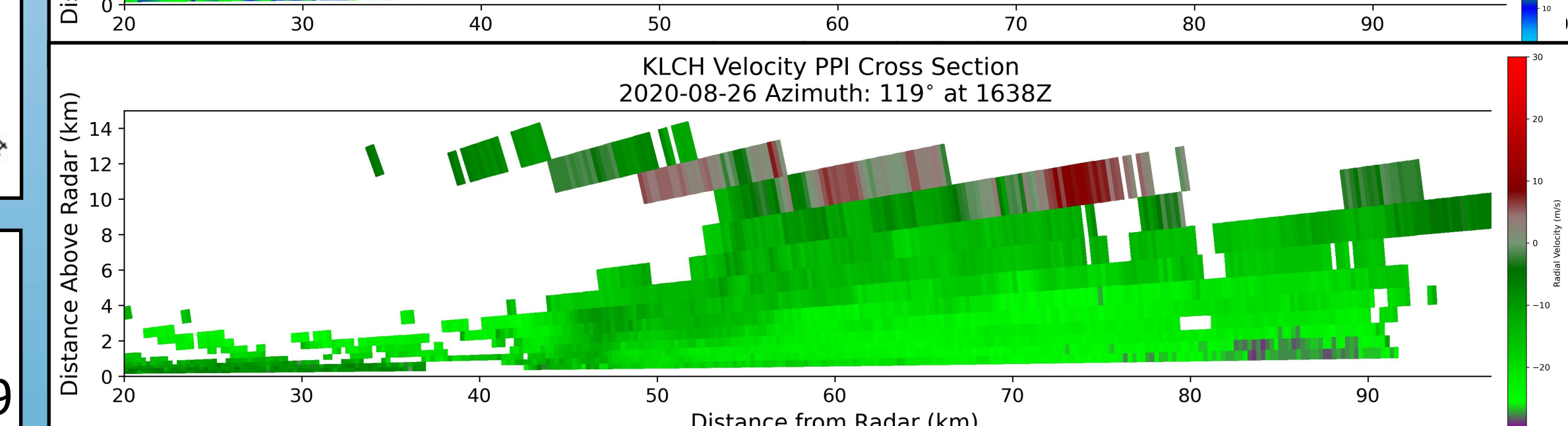
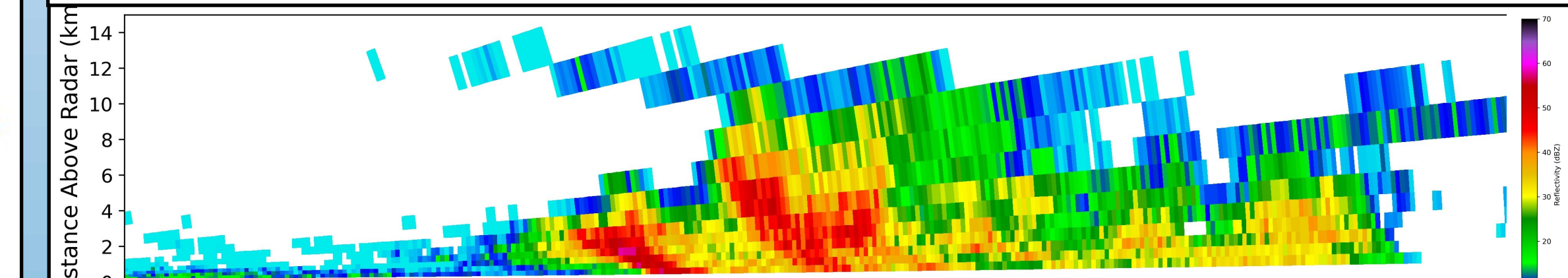
## Average Approximate Propagation Speed,

15-17Z: 7.130 m/s

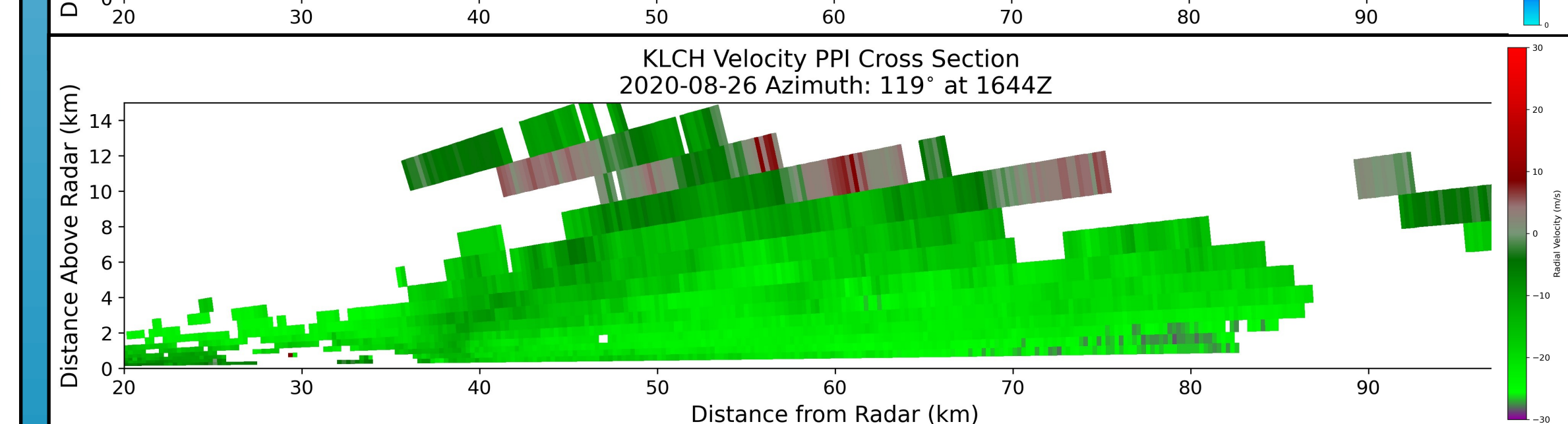
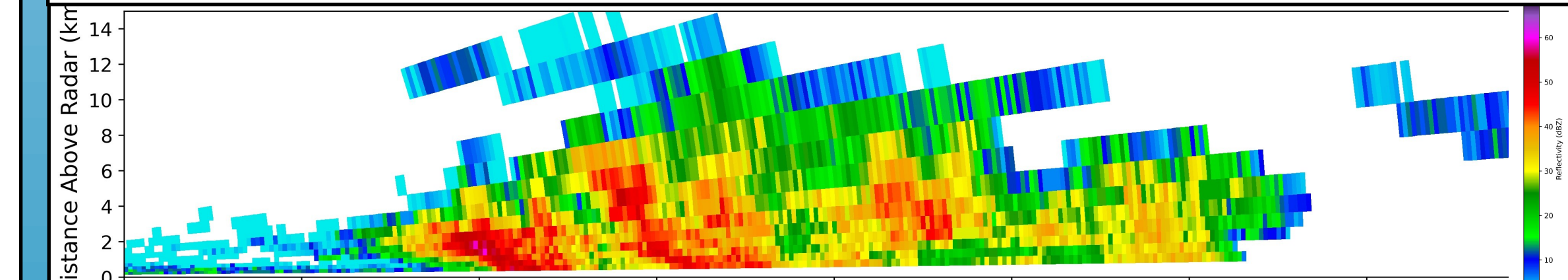
## Model of Mature Squall Line—Houze et al. 1989



## KLCH quasi-RHI, 1638Z, 119° azimuth



## KLCH quasi-RHI, 1644Z, 119° azimuth



**Future Work & Acknowledgements:** This work will be continued in two new cases for Isaias (2020) and Ida (2021) for my master's thesis. Thanks to Dr. Patrick Duran, the civil servants of NASA SPoRT, my committee members, and Ryan Wade for their guidance and encouragement throughout this process.